

CLAIMS LISTING

3	1. (currently amended)	A method for optimizing a wireless electromagnetic
4	communications network, o	comprising:
5	a wireless electroma	agnetic communications network, comprising
6	a set of node	es, said set of nodes further comprising,
7	at lea	ast a first subset wherein each node is MIMO-capable,
8	comp	orising:
9		an antennae array of M [M] antennae, where M [M] \geq one,
10		a transceiver for each antenna in said spatially diverse
11		antennae array,
12		means for digital signal processing to convert analog radio
13		signals into digital signals and digital signals into analog
14		radio signals,
15		means for coding and decoding data, symbols, and control
16		information into and from digital signals,
17		diversity capability means for transmission and reception of
18		said analog radio waves[signals],
19		and,
20		means for input and output from and to a non-radio
21		interface for digital signals;
22	said set of	nodes being deployed according to design rules that prefer
23	meeting the	following criteria:
24	said	set of nodes further comprising two or more proper subsets of
25	node	s, with a first proper subset being the transmit uplink / receive
26	down	nlink set, and a second proper subset being the transmit
27	down	nlink / receive uplink set;
28	each	node in said set of nodes belonging to no more transmitting
29	uplin	k or receiving uplink subsets than it has diversity capability
30	mear	ns:

31	each node in a transmit uplink / receive downlink subset has no	
32	more nodes with which it will hold time and frequency coincident	
33	communications in its field of view, than it has diversity capability	
34	[means];	
35	each node in a transmit downlink / receive uplink subset has no	
36	more nodes with which it will hold time and frequency coincident	
37	communications in its field of view, than it has diversity capability	
38	[means];	
39	each member of a transmit uplink / receive downlink subset cannot	
40	hold time and frequency coincident communications with any	
41	other member of that transmit uplink / receive downlink subset;	
42	and,	
43	each member of a transmit downlink / receive uplink subset cannot	
44	hold time and frequency coincident communications with any	
45	other member of that transmit downlink / receive uplink subset;	
46	transmitting, in said wireless electromagnetic communications network,	
47	independent information from each node belonging to a first proper subset, to one	
48	or more receiving nodes belonging to a second proper subset that are viewable	
49	from the transmitting node;	
50	processing independently, in said wireless electromagnetic communications	
51	network, at each receiving node belonging to said second proper subset,	
52	information transmitted from one or more nodes belonging to said first proper	
53	subset;	
54	and,	
55	dynamically adapting the diversity ehannels[capability means] and said proper	
56	subsets to optimize said network.	
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59	2. (currently amended) A method for optimizing a wireless electromagnetic	
60	communications network, comprising:	
61	a wireless electromagnetic communications network, comprising	

62	a set of nodes, said set of nodes further comprising,	
63	at least a first subset wherein each node is MIMO-capable,	
64	comprising:	
65	a spatially diverse antennae array of M [M] antennae,	
66	where $M[M] \ge two$,	
67	a transceiver for each antenna in said spatially diverse	
68	antennae array,	
69	means for digital signal processing to convert analog radio	
70	signals into digital signals and digital signals into analog	
71	radio signals,	
72	means for coding and decoding data, symbols, and control	
73	information into and from digital signals,	
74	diversity capability means for transmission and reception of	
75	said analog radio waves [signals],	
76	and,	
77	means for input and output from and to a non-radio	
78	interface for digital signals;	
79	said set of nodes being deployed according to design rules that prefer	
80	meeting the following criteria:	
81	said set of nodes further comprising two or more proper subsets of	
82	nodes, with a first proper subset being the transmit uplink / receive	
83	downlink set, and a second proper subset being the transmit	
84	downlink / receive uplink set;	
85	each node in said set of nodes belonging to no more transmitting	
86	uplink or receiving uplink subsets than it has diversity capability	
87	means;	
88	each node in a transmit uplink / receive downlink subset has no	
89	more nodes with which it will hold time and frequency coincident	
90	communications in its field of view, than it has diversity capability	
91	[means];	

92 each node in a transmit downlink / receive uplink subset has no 93 more nodes with which it will hold time and frequency coincident 94 communications in its field of view, than it has diversity capability 95 [means]; 96 each member of a transmit uplink / receive downlink subset cannot 97 hold time and frequency coincident communications with any 98 other member of that transmit uplink / receive downlink subset; 99 and, 100 each member of a transmit downlink / receive uplink subset cannot 101 hold time and frequency coincident communications with any 102 other member of that transmit downlink / receive uplink subset; 103 transmitting, in said wireless electromagnetic communications network, 104 independent information from each node belonging to a first proper subset, to one 105 or more receiving nodes belonging to a second proper subset that are viewable 106 from the transmitting node; 107 processing independently, in said wireless electromagnetic communications 108 network, at each receiving node belonging to said second proper subset. 109 information transmitted from one or more nodes belonging to said first proper 110 subset; 111 and, 112 dynamically adapting the diversity channels [capability means] and said proper 113 subsets to optimize said network. 114 115 116 3. (currently amended) A method as in claim 1, wherein dynamically adapting the 117 diversity ehannels [capability means] and said proper subsets to optimize said network 118 further comprises: 119 using substantive null steering to minimize SINR between nodes transmitting and 120 receiving information. 121 122

123	4. (currently amended) A method as in claim 1, wherein dynamically adapting the
124	diversity ehannels [capability means] and said proper subsets to optimize said network
125	further comprises:
126	using max-SINR null- and beam-steering to minimize intra-network interference
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129	5. (currently amended) A method as in claim 1, wherein dynamically adapting the
130	diversity ehannels [capability means] and said proper subsets to optimize said network
131	further comprises:
132	using MMSE null- and beam-steering to minimize intra-network interference.
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135	6. (currently amended) A method as in claim 1, wherein dynamically adapting the
136	diversity ehannels [capability means] and said proper subsets to optimize said network
137	further comprises:
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139	designing the network such that reciprocal symmetry exists for each pairing of
140	uplink receive and downlink receive proper subsets.
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142	7. (currently amended) A method as in claim 1, wherein dynamically adapting the
143	diversity ehannels [capability means] and said proper subsets to optimize said network
144	further comprises:
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146	designing the network such that substantial reciprocal symmetry exists for each
147	pairing of uplink receive and downlink receive proper subsets.
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149	8. (original) A method as in claim 1, wherein the network uses TDD communication
150	protocols.
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152	9. (original) A method as in claim 1, wherein the network uses FDD communication
153	protocols.

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        10. (original) A method as in claim 3, wherein the network uses simplex communication
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        protocols.
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        11. (original) A method as in claim 1, wherein the network uses random access packets,
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        and receive and transmit operations are all carried out on the same frequency channels for
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        each link.
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        12. (currently amended)
                                        A method as in claim 1, wherein dynamically adapting the
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        diversity ehannels [capability means] and said proper subsets to optimize said network
 164
        further comprises
 165
 166
                if the received interference is spatially white in both link directions, setting
                g_1(aq) \alpha W^*_2q and g_2(q) \alpha W^*_1(q)
167
                [ \mathbf{g}_2(q) \propto \mathbf{w}_2^*(q) and \mathbf{g}_1(q) \propto \mathbf{w}_1^*(q) ] at both ends of the link,
168
                where \{g_2(q), W_1(q)\}
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                [ \{\mathbf{g}_2(q), \mathbf{w}_1(q)\} ] are the linear transmit and receive weights used in the
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171
                downlink;
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                but if the received interference is not spatially white in both link directions,
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                constraining \{\mathbf g_1(\mathbf q)\} and \{\mathbf g_2(\mathbf q)\} \{\mathbf g_1(q)\} and [\{\mathbf g_2(q)\}] to
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175
                preferentially satisfy:
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177
                \sum_{g}^{T} (q) R_{i+i} [n_{i}(q)] g^{*} (q) = \sum_{g} Tr \{R_{i+i} (n)\} = M_{i} R_{i}
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channels further comprises:

if the received interference is spatially white in both link directions, setting $g_1(aq) \propto w^*_2q$ and $g_2(q) \propto w^*_1(q)$ [$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(\mathbf{q}) \propto \mathbf{w}_1^*(q)$] at both ends of the link, where $\{g_2(q), W_1(q)\}$ [$\{g_2(q), W_1(q)\}$] are the linear transmit and receive weights used in the downlink; but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ [$\{g_1(q)\}$ and $\{g_2(q)\}$] to preferentially satisfy: $\sum_{g} \mathbf{g}^{T}_{1}(g) \mathbf{R}_{i1i1} [\mathbf{n}_{1}(g)] \mathbf{g}^{*}_{1}(g) = \sum_{g} \mathbf{Tr} \{\mathbf{R}_{i1i1}(g)\} = \mathbf{M}_{1} \mathbf{R}_{1}$ $\sum_{g} g^{T}_{2}(g) R_{i2i2} [n_{2}(g)] g^{*}_{2}(g) = \sum_{g} Tr\{R_{i2i2}(n)\} = M_{2}R_{2}$ [$\sum_{l=1}^{Q_{21}} \mathbf{g}_{1}^{T}(q) \mathbf{R}_{\mathbf{i}_{1} \mathbf{i}_{1}}(n_{1}(q)) \mathbf{g}_{1}^{*}(q) = \sum_{l=1}^{N_{1}} \operatorname{Tr} \{ \mathbf{R}_{\mathbf{i}_{1} \mathbf{i}_{1}}(n) \} = M_{1} R_{1}$

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$$\sum_{q=1}^{Q_{12}} \mathbf{g}_{2}^{T}(q) \mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n_{2}(q)) \mathbf{g}_{2}^{*}(q) = \sum_{n=1}^{N_{2}} \operatorname{Tr}\{\mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n)\} = M_{2}R_{2} \quad \text{1.}$$

17. (original) A method as in claim 1, wherein the means for digital signal processing in said first subset of MIMO-capable nodes further comprises:

an ADC bank for downconversion of received RF signals into digital signals; a MT DEMOD element for multitone demodulation, separating the received signal into distinct tones and splitting them into 1 through $K[K]_{feed}$ FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT DEMOD element further comprising

a Comb element with a multiple of 2 filter capable of operating on a 128-bit sample; and,

an FFT element with a 1,024 real-IF function;

a Mapping element for mapping the demodulated multitone signals into a 426 active receive bins, wherein

each bin covers a bandwidth of 5.75MHz;

each bin has an inner passband of 4.26MHz for a content envelope;

each bin has an external buffer, up and down, of 745kHz;

each bin has 13 channels, CH0 through CH12, each channel having 320

kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner

30 tones being used information bearing and T0 and T31 being reserved;

each signal being 100µs, with 12.5µs at each end thereof at the front and

rear end thereof forming respectively a cyclic prefix and cyclic suffix

buffer to punctuate successive signals;

254 and,

a symbol-decoding element for interpretation of the symbols embedded in the

signal.

18. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity channels [capability means] and said proper subsets to optimize said network further comprises

using at each node the receive combiner weights as transmit distribution weights
during subsequent transmission operations, so that the network is preferentially
designed and constrained such that each link is substantially reciprocal, such that
the ad hoc network capacity measure can be made equal in both link directions by
setting at both ends of the link:

$$g_2(q) \propto w^*_2(k,q)$$
 and $g_1(k,q) \propto w^*_1(k,q)$

[
$$\mathbf{g}_2(k,q) \propto \mathbf{w}_2^*(k,q) \text{ and } \mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)$$
],

where $\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}$ [$\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}$] are the linear transmit and receive weights to transmit data $d_2(k,q)$ from node $n_2(q)$ to node $n_1(q)$ over channel k in the downlink, and where $\{\mathbf{g}_1(k,q),\mathbf{w}_2(k,q)\}$ are the linear transmit and receive weights used to transmit data $d_1(k,q)$ from node $n_1(q)$ back to node $n_2(q)$ over equivalent channel k in the uplink.

19. (currently amended) A method as in claim 1, wherein the step of each node in a transmit downlink / receive uplink subset having no more nodes with which it will hold

284	time and frequency coincident communications in its field of view, than it has diversity	
285	capability [means] further comprises:	
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287	designing the topological, physical layout of nodes to enforce this constraint	
288	within the node's diversity channel means limitations.	
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290	$oldsymbol{\cdot}$	
29 1	20. (currently amended) A method as in claim 1, wherein the step of each node in a	
292	transmit uplink / receive downlink subset having no more nodes with which it will hold	
293	time and frequency coincident communications in its field of view, than it has diversity	
294	capability [means] further comprises:	
295	designing the topological, physical layout of nodes to enforce this constraint	
296	within the node's diversity channel means limitations.	
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299	21. (currently amended) A method as in claim 1, wherein the step of dynamically	
300	adapting the diversity ehannels [capability means] and said proper subsets to optimize	
301	said network further comprises:	
302	allowing a proper subset to send redundant data transmissions over multiple	
303	frequency channels to another proper subset.	
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306	22. (original) A method as in claim 1, wherein the step of dynamically adapting the	
307	diversity ehannels [capability means] and said proper subsets to optimize said network	
308	further comprises:	
309	allowing a proper subset to send redundant data transmissions over multiple	
310	simultaneous or differential time slots to another proper subset.	
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513	23. (original) A method as in claim 1, wherein said transmitting proper subset and
314	receiving proper subset diversity capability means for transmission and reception of said
315	analog radio waves [signals] further comprise:
316	spatial diversity of antennae.
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319	24. (original) A method as in claim 1, wherein said transmitting proper subset and
320	receiving proper subset diversity capability means for transmission and reception of said
321	analog radio waves [signals] further comprise:
322	polarization diversity of antennae.
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325	25. (original) A method as in claim 1, wherein said transmitting proper subset and
326	receiving proper subset diversity capability means for transmission and reception of said
327	analog radio waves [signals] further comprise:
328	any combination of temporal, spatial, and polarization diversity of antennae.
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331	26. (currently amended) A method as in claim 1, wherein the step of dynamically
332	adapting the diversity ehannels [capability means] and said proper subsets to optimize
333	said network further comprises:
334	incorporating network control and feedback aspects as part of the signal encoding
335	process.
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338	27. (currently amended) A method as in claim 1, wherein the step of dynamically
339	adapting the diversity ehannels [capability means] and said proper subsets to optimize
340	said network further comprises:
341	incorporating network control and feedback aspects as part of the signal encoding
342	process and including said as network information in one direction of the
343	signalling and optimization process using the perceived environmental

344	condition's effect upon the signals in the other direction of the signalling and	
345	optimization process.	
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348	28. (currently amended) A method as in claim 1, wherein the step of dynamically	
349	adapting the diversity ehannels [capability means] and said proper subsets to optimize	
350	said network further comprises:	
351	adjusting the diversity ehannel [capability means] use between any proper sets of	
352	nodes by rerouting any active link based on perceived unacceptable SINR	
353	experienced on that active link and the existence of an alternative available link	
354	using said adjusted diversity ehannel [capability means].	
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357	29. (currently amended) A method as in claim 1, wherein the step of dynamically	
358	adapting the diversity ehannels [capability means] and said proper subsets to optimize	
359	said network further comprises:	
360	switching a particular node from one proper subset to another due to changes in	
361	the external environment affecting links between that node and other nodes in the	
362	network.	
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365	30. (currently amended) A method as in claim 1, wherein the step of dynamically	
366	adapting the diversity ehannels [capability means] and said proper subsets to optimize	
367	said network further comprises:	
368	dynamically reshuffling proper subsets to more closely attain network objectives	
369	by taking advantage of diversity channel availability.	
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372	31. (currently amended) A method as in claim 1, wherein the step of dynamically	
373	adapting the diversity channels [capability means] and said proper subsets to optimize	
374	said network further comprises:	

3/3	dynamically reshuffling proper subsets to more closely attain network objectives	
376	by accounting for node changes.	
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379	32. (currently amended) A method as in claim 31, wherein said node changes	
380	include any of:	
381	adding diversity capability [means] to a node, adding a new node within the field	
382	of view of another node, removing a node from the network (temporarily or	
383	permanently), or losing diversity capability [means] at a node.	
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386	33. (currently amended) A method as in claim 1, wherein the step of dynamically	
387	adapting the diversity ehannels [capability means] and said proper subsets to optimize	
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389	suppressing unintended recipients or transmitters by the imposition of signal	
390	masking.	
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393	34. (original) A method as in claim 33, wherein the step of suppressing unintended	
394	recipients or transmitters by the imposition of signal masking further comprises:	
395	imposition of an origination mask.	
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398	34. (original) A method as in claim 33, wherein the step of suppressing unintended	
399	recipients or transmitters by the imposition of signal masking further comprises:	
400	imposition of a recipient mask.	
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403	35. (original) A method as in claim 33, wherein the step of suppressing unintended	
404	recipients or transmitters by the imposition of signal masking further comprises:	
405	imposition of any combination of origination and recipient masks.	

406 407 408 36. (currently amended) A method as in claim 33, wherein the step of dynamically 409 adapting the diversity ehannels [capability means] and said proper subsets to optimize 410 said network further comprises: 411 using signal masking to secure transmissions against unintentional, interim 412 interception and decryption by the imposition of a signal mask at origination, the 413 transmission through any number of intermediate nodes lacking said signal mask, 414 and the reception at the desired recipient which possesses the correct means for 415 removal of the signal mask. 416 417 418 37. (original) A method as in claim 36, wherein the signal masking is shared by a proper 419 subset. 420 421 422 38. (currently amended) A method as in claim 1, wherein the step of dynamically 423 adapting the diversity ehannels [capability means] and said proper subsets to optimize 424 said network further comprises: 425 heterogenous combination of a hierarchy of proper subsets, one within the other, 426 each paired with a separable subset wherein the first is a transmit uplink and the 427 second is a transmit downlink subset, such that the first subset of each pair of 428 subsets is capable of communication with the members of the second subset of 429 each pair, yet neither subset may communicate between its own members. 430 431 432 39. (original) A method as in claim 1, wherein the step of dynamically adapting the 433 diversity channels [capability means] and said proper subsets to optimize said network 434 further comprises:

435	using as many of the available diversity ehannels [capability means] as are needed		
436	for traffic between any two nodes from 1 to NumChannels, where NumChannels		
437	equals the maximal diversity capability [means] between said two nodes.		
438			
439	40. (original) A method as in claim	1, wherein the step of dynamically adapting the	
440	diversity ehannels [capability means	and said proper subsets to optimize said network	
441	further comprises:		
442	usng [using] a water-filling algorithm to route traffic between an origination and		
443	destination node through any intermediate subset of nodes that has available		
444	diversity channel [capability	means] capacity.	
445	•		
446			
447	41. (currently amended) A met	nod for optimizing a wireless electromagnetic	
448	communications network, comprisin	g:	
449	a wireless electromagnetic communications network, comprising		
450	a set of nodes, said set further comprising,		
451	at least a first subset of MIMO-capable nodes, each MIMO-		
452	capable node comprising:		
453	a spatially diverse antennae array of $M[M]$ antennae, where		
454	$M[M] \ge two$, said antennae array being polarization		
455	diverse, and circularly symmetric, and providing 1-to-M		
456	RF feeds;		
457	a trans	ceiver for each antenna in said array, said transceiver	
458	further	comprising	
459		a Butler Mode Forming element, providing spatial	
460		signature separation with a FFT-LS algorithm,	
461		reciprocally forming a transmission with shared	
462		receiver feeds, such that the number of modes out	
463.	equals the numbers of antennae, establishing such		
464	as an ordered set with decreasing energy, further		
465	•	comprising:	

466	a dual-polarization element for splitting the
467	modes into positive and negative polarities
468	with opposite and orthogonal polarizations,
469	that can work with circular polarizations,
470	and
471	a dual-polarized link CODEC;
472	a transmission/reception switch comprising,
473	a vector OFDM receiver element;
474	a vector OFDM transmitter element;
475	a LNA bank for a receive signal, said LNA
476	Bank also instantiating low noise
477 .	characteristics for a transmit signal;
478	a PA bank for the transmit signal that
479	receives the low noise characteristics for
480	said transmit signal from said LNA bank;
481	an AGC for said LNA bank and PA bank;
482	a controller element for said
483	transmission/reception switch enabling
484	baseband link distribution of the energy over
485	the multiple RF feeds on each channel to
486	steer up to $K[K]_{feed}$ beams and nulls
487	independently on each FDMA channel;
488	a Frequency Translator;
489	a timing synchronization element controlling
490	said controller element;
491	further comprising a system clock,
492	a universal Time signal element;
493	GPS;
494	a multimode power management element
495	and algorithm;
496	and,

497	a LOs element;
498	said vector OFDMreceiver element comprising
499	an ADC bank for downconversion of
500	received RF signals into digital signals;
501	a MT DEMOD element for multitone
502	demodulation, separating the received signal
503	into distinct tones and splitting them into 1
504	through $K[K]_{feed}$ FDMA channels, said
505	separated tones in aggregate forming the
506	entire baseband for the transmission, said
507	MT DEMOD element further comprising
508	a Comb element with a multiple of 2
509	filter capable of operating on a 128-
510	bit sample; and,
511	an FFT element with a 1,024 real-IF
512	function;
513	a Mapping element for mapping the
514	demodulated multitone signals into a 426
515	active receive bins, wherein
516	each bin covers a bandwidth of
517	5.75MHz [5.75 MHz];
518	each bin has an inner passband of
519	4.26MHz [4.26 MHz]for a content
520	envelope;
521	each bin has an external buffer, up
522	and down, of 745kHz [745 kHz];
523	each bin has 13 channels, CH0
524	through CH12, each channel having
525	320 kHz and 32 tones, T0 through
526	T31, each tone being 10kHz [10
527	kHz], with the inner 30 tones being

528	used information bearing and T0 and
529	T31 being reserved;
530	each signal being 100μs [100 μs[,
531	with 12.5μs [12.5 μs] at each end
532	thereof at the front and rear end
533	thereof forming respectively a cyclic
534	prefix and cyclic suffix buffer to
535	punctuate successive signals;
536	a MUX element for timing modification
537	capable of element-wise multiplication
538	across the signal, which halves the number
539	of bins and tones but repeats the signal for
540	high-quality needs;
541	a link CODEC, which separates each FDMA
542	channel into 1 through M [M] links, further
543	comprising
544	a SOVA bit recovery element;
545	an error coding element;
546	an error detection element;
547	an ITI remove element;
548	a tone equalization element;
549	and,
550	a package fragment retransmission
551	element;
552	a multilink diversity combining element,
553	using a multilink Rx weight adaptation
554	algorithm for Rx signal weights $\frac{W(k)}{}$
555	[$\mathbf{W}(k)$] to adapt transmission gains
556	G(k) [$G(k)$] for each channel k [k];

557	an equalization algorithm, taking the signal
558	from said multilink diversity combining
559	element and controlling a delay removal
560	element;
561	said delay removal element separating signal
562	content from imposed pseudodelay and
563	experienced environmental signal delay, and
564	passing the content-bearing signal to a
565	symbol-decoding element;
566	said symbol-decoding element for
567	interpretation of the symbols embedded in
568	the signal, further comprising:
569	an element for delay gating;
570	a QAM element; and
571	a PSK element;
572	said vector OFDM transmitter element comprising:
573	a DAC bank for conversion of digital signals
573 574	a DAC bank for conversion of digital signals into RF signals for transmission;
574	into RF signals for transmission;
574 575	into RF signals for transmission; a MT MOD element for multitone
574 575 576	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the
574 575 576 577	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through
574 575 576 577 578	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated
574 575 576 577 578 579	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire
574 575 576 577 578 579	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT
574 575 576 577 578 579 580	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising
574 575 576 577 578 579 580 581	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising a Comb element with a multiple of 2
574 575 576 577 578 579 580 581 582 583	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising a Comb element with a multiple of 2 filter capable of operating on a 128-
574 575 576 577 578 579 580 581 582 583 584	into RF signals for transmission; a MT MOD element for multitone modulation, combining and joining the signal to be transmitted from 1 through K[K] _{feed} FDMA channels, said separated tones in aggregate forming the entire baseband for the transmission, said MT MOD element further comprising a Comb element with a multiple of 2 filter capable of operating on a 128- bit sample; and,

587	a Mapping element for mapping the
588	modulated multitone signals from 426
589	active transmit bins, wherein
590	each bin covers a bandwidth of
591	5.75MHz [5.75 MHz];
592	each bin has an inner passband of
593	4.26MHz [4.26 MHz] for a content
594	envelope;
595	each bin has an external buffer, up
596	and down, of 745kHz [745 kHz];
597	each bin has 13 channels, CH0
598	through CH12, each channel having
599	320 kHz and 32 tones, T0 through
600	T31, each tone being 10kHz [10
601	kHz], with the inner 30 tones being
602	used information bearing and T0 and
603	T31 being reserved;
604	each signal being 100μs [100 μs],
605	with $\frac{12.5\mu s}{12.5}$ [12.5 μs] at each end
606	thereof at the front and rear end
607	thereof forming respectively a cyclic
608	prefix and cyclic suffix buffer to
609	punctuate successive signals;
610	a MUX element for timing modification
611	capable of element-wise multiplication
612	across the signal, which halves the number
613	of bins and tones but repeats the signal for
614	high-quality needs;
615	a symbol-coding element for embedding the
616	symbols to be interpreted by the receiver in
617	the signal, further comprising:

618	an element for delay gating;
619	a QAM element; and
620	a PSK element;
621	a link CODEC, which aggregates each
622	FDMA channel from 1 through M [M] links,
623	further comprising
624	a SOVA bit recovery element;
625	an error coding element;
626	an error detection element;
627	an ITI remove element;
628	a tone equalization element;
629	and,
630	a package fragment retransmission
631	element;
632	a multilink diversity distribution element,
633	using a multilink Tx weight adaptation
634	algorithm for Tx signal weights to adapt
635	transmission gains $\mathbf{G}(\mathbf{k})$ [$\mathbf{G}(k)$] for
636	each channel \mathbf{k} [k], such that $\mathbf{g}(\mathbf{q};\mathbf{k})$
637	$\alpha \mathbf{w}^*(\mathbf{q};\mathbf{k}) [\mathbf{g}(q;\mathbf{k}) \propto \mathbf{w}^*(q;\mathbf{k})];$
638	a TCM codec;
639	a pilot symbol CODEC element that integrates with said
640	FFT-LS algorithm a link separation, a pilot and data signal
641	elements sorting, a link detection, multilink combination,
642	and equalizer weight calculation operations;
643	means for diversity transmission and reception,
644	and,
645	means for input and output from and to a non-radio
646	interface;
647	

648 said set of nodes being deployed according to design rules that prefer 649 meeting the following criteria: 650 said set of nodes further comprising two or more proper subsets of 651 nodes, with a first proper subset being the transmit uplink / receive 652 downlink set, and a second proper subset being the transmit 653 downlink / receive uplink set; 654 655 each node in said set of nodes belonging to no more transmitting 656 uplink or receiving uplink subsets than it has diversity capability 657 means; 658 659 each node in a transmit uplink / receive downlink subset has no 660 more nodes with which it will hold time and frequency coincident 661 communications in its field of view, than it has diversity capability 662 [means]; 663 664 each node in a transmit downlink / receive uplink subset has no 665 more nodes with which it will hold time and frequency coincident 666 communications in its field of view, than it has diversity capability 667 [means]; 668 669 each member of a transmit uplink / receive downlink subset cannot 670 hold time and frequency coincident communications with any 671 other member of that transmit uplink / receive downlink subset; 672 673 and, 674 675 each member of a transmit downlink / receive uplink subset cannot 676 hold time and frequency coincident communications with any 677 other member of that transmit downlink / receive uplink subset: 678

transmitting, in said wireless electromagnetic communications network, independent information from each node belonging to a first proper subset, to one or more receiving nodes belonging to a second proper subset that are viewable from the transmitting node;

processing independently, in said wireless electromagnetic communications network, at each receiving node belonging to said second proper subset, information transmitted from one or more nodes belonging to said first proper subset;

and,

designing the network such that substantially reciprocal symmetry exists for the uplink and downlink channels by,

if the received interference is spatially white in both link directions, setting

$$g_1(a) \propto w^*_2 q$$
 and $g_2(q) \propto w^*_1(q)$

[$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$] at both ends of the

link, where $\{\mathbf{g}_2(\mathbf{q}), \mathbf{w}_1(\mathbf{q})\}$ [$\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$] are the linear

transmit and receive weights used in the downlink;

but if the received interference is not spatially white in both link

701 directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$

[$\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$] to satisfy:

704 Q₂₁

 Q_{12} $\sum g^{T}_{2}(q)R_{i2i2}[n_{2}(q)]g^{*}_{2}(q)$ $\sum Tr\{R_{i2i2}(n)\} = M_2R_{2,i}$ $\sum_{q=1}^{Q_{21}} \mathbf{g}_{1}^{T}(q) \mathbf{R}_{\mathbf{i}_{1} \mathbf{i}_{1}}(n_{1}(q)) \mathbf{g}_{1}^{*}(q) = \sum_{q=1}^{N_{1}} \operatorname{Tr} \{ \mathbf{R}_{\mathbf{i}_{1} \mathbf{i}_{1}}(n) \} = M_{1} R_{1}$ $\sum_{i=1}^{Q_{12}} \mathbf{g}_{2}^{T}(q) \mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n_{2}(q)) \mathbf{g}_{2}^{*}(q) = \sum_{i=1}^{N_{2}} \operatorname{Tr}\{\mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n)\} = M_{2}R_{2};$ using any standard communications protocol, including TDD, FDD, simplex, and, optimizing the network by dynamically adapting the diversity ehannels [capability means] between nodes of said transmitting and receiving subsets.

730	
731	
732	42. (original) A method as in claim 41, wherein said a transmission/reception switch
733	further comprises:
734	
735	an element for tone and slot interleaving.
736	
737	43. (original) A method as in claim 41, wherein said TMC codec and SOVA decoder are
738	replaced with a Turbo codec.
739	
740	44. (currently amended) A method as in claim 1, wherein the step of
741	dynamically adapting the diversity ehannels [capability means] and said proper subsets to
742	optimize said network further comprises:
743	optimizing at each node acting as a receiver the receive weights using the [a]
744	MMSE technique to adjust the multitone transmissions between it and other
745	nodes.
746	
747	
748	45. (currently amended) A method as in claim 1, wherein the step of dynamically
749	adapting the diversity ehannels [capability means] and said proper subsets to optimize
750	said network further comprises:
751	optimizing at each node acting as a receiver the receive weights using the MAX
752	[maximum] SINR to adjust the multitone transmissions between it and other
753	nodes.
754	
755	
756	46. (currently amended) A method as in claim 1, wherein the step of dynamically
757	adapting the diversity ehannels [capability means] and said proper subsets to optimize
758	said network further comprises:
759	optimizing at each node acting as a receiver the receive weights, then optimizing
760	the transmit weights at that node by making them proportional to the receive

761 weights, and then optimizing the transmit gains for that node by a max-min 762 criterion for the link capacities for that node at that particular time. 763 764 765 47. (currently amended) A method as in claim 1, wherein the step of dynamically 766 adapting the diversity channels [capability means] and said proper subsets to optimize 767 said network further comprises: 768 including, as part of said network, one or more network controller elements that 769 assist in tuning local node's maximum eapactiy [capacity] criteria and link 770 channel diversity usage to network constraints. 771 772 773 48. (currently amended) A method as in claim 1, wherein the step of dynamically 774 adapting the diversity channels [capability means] and said proper subsets to optimize 775 said network further comprises: characterizing the channel response vector $\mathbf{a}_1(f,t;n_2,n_1)$ by the observed 776 (possibly time-varying) azimuth and elevation $\{\theta_1(t;n_2,n_1),$ 777 $\varphi_1(f,t;n_2,n_1)$ of node n_2 observed at n_1 . 778 779 780 49. (currently amended) A method as in claim 1, wherein the step of dynamically 781 adapting the diversity ehannels [capability means] and said proper subsets to optimize 782 said network further comprises: characterizing the channel response vector $\mathbf{a}_1(f,t;n_2,n_1)$ as a superposition of 783 direct-path and near-field reflection path channel responses, e.g., due to scatterers 784 in the vicinity of n_1 , such that each element of $\mathbf{a}_1(f,t;n_2,n_1)$ can be modeled 785 786 as a random process, possibly varying over time and frequency.

788 50. (currently amended) A method as in claim 1, wherein the step of dynamically adapting the diversity ehannels [capability means] and said proper subsets to optimize said network further comprises:

presuming that $\mathbf{a}_1(f,t;n_2,n_1)$ and $\mathbf{a}_1(f,t;n_{2[1]},n_{4[2]})$ can be substantively time invariant over significant time durations, e.g., large numbers of OFDM symbols or TDMA time frames, and inducing the most significant frequency and time variation by the observed timing and carrier offset on each link.

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798 51. (currently amended) A method as in claim 1, wherein the step of dynamically 799 adapting the diversity channels [capability means] and said proper subsets to optimize 800 said network further comprises:

801 in such networks, e.g., TDD networks, wherein the transmit and receive frequencies are identical $(f_{21}(k) = f_{12}(k) = f(k))$ and the transmit and 802 receive time slots are separated by short time intervals $(t_{21}(l) = t_{12}(l) + \Delta_{21}$ 803 $\approx t(l)$, and $\mathbf{H}_{21}(k,l)$ and $\mathbf{H}_{21}(k,l)$ and $\mathbf{H}_{21}(k,l)$ and 804 $\mathbf{H}_{12}(k,l)$] become substantively reciprocal, such that the subarrays 805 comprising $\mathbf{H}_{21}(k_5 l)$ and $\mathbf{H}_{21}(k_5 l)$ [$\mathbf{H}_{21}(k, l)$] and $\mathbf{H}_{12}(k, l)$ 806] satisfy $\mathbf{H}_{21}(k, l; n_2, n_1) \approx \delta_{21}(k, l; n_1, n_2) \mathbf{H}^{T}_{12} [\mathbf{H}_{12}^{T}](k, l; n_1, n_2)$ 807 (n_1,n_2) , where $\delta_{21}(k,l,n_1,n_2)$ is a unit-magnitude, generally 808 809 nonreciprocal scalar, equalizing the observed timing offsets, carrier offsets, and phase offsets, such that $\lambda_{21}(n_2,n_1) \approx \lambda_{12}(n_1,n_2), \; au_{21}(n_2,n_1) \approx$ 810 $\tau_{12}(n_{2[1]}, n_{4[2]})$, and $v_{21}(n_1, n_2) \approx v_{12} (n_{2[1]}, n_{4[2]})$, by 811 812 synchronizing each node to an external, universal time and frequency standard,

obtaining $\delta_{21}(k, l; n_{1/2}, n_{2/1}) \approx 1$, and establishing network channel 813 response as truly reciprocal $\mathbf{H}_{21}(k,l) \approx \mathbf{H}_{21}^T [\mathbf{H}_{12}^T](k,l)$. 814 815 816 817 52. A method as in claim 51, wherein the synchronization of each node is to Global 818 Position System Universal Time Coordinates (GPS UTC). 819 820 821 53. (original) A method as in claim 51, wherein the synchronization of each node is to a 822 network timing signal. 823 824 825 54. (original) A method as in claim 51, wherein the synchronization of each node is to a 826 combination of Global Position System Universal Time Coordinates (GPS UTC) and a 827 network timing signal. 828 829 830 55. (currently amended) A method as in claim 1, wherein the step of dynamically 831 adapting the diversity channels [capability means] and said proper subsets to optimize 832 said network further comprises: 833 for such parts of the network where the internode channel responses possess substantive multipath, such that $\mathbf{H}_{21}(k, l; n_2, n_1)$ and \mathbf{H}_{21} [12] $(k, l; n_2, n_1)$ 834 $;n_{2[1]},n_{4[2]})$ have rank greater than unity, making the channel response 835 836 substantively reciprocal by: 837 838 (1) forming uplink and downlink transmit signals using the matrix formula 839 in EQ. 40 $\mathbf{s}_{1}(k,l;n_{1}) = \mathbf{G}_{1}(k,l;n_{1}) \, \mathbf{d}_{1}(k,l;n_{1})$ 840

$$\mathbf{s}_{2}(k,l;n_{1}) = \mathbf{G}_{2}(k,l;n_{2}) \mathbf{d}_{2}(k,l;n_{2});$$

842 (2) reconstructing the data intended for each receive node using the matrix formula in EQ. 41

844
$$\mathbf{y}_{1}(k,l;n_{1}) = \mathbf{W}^{H}_{1}(k,l;n_{1}) \mathbf{x}_{1}(k,l;n_{1})$$

845
$$\mathbf{y}_{2}(k,l;n_{2}) = \mathbf{W}^{H}_{2}(k,l;n_{2}) \mathbf{x}_{2}(k,l;n_{2});$$

- (3) developing combiner weights that $\{\mathbf{w}_1(k,l;n_2,n_1)\}$ and $\{\mathbf{w}_2(k,l;n_1,n_2)\}$ that substantively null data intended for recipients during the symbol recovery operation, such that for $n_1 \neq n_2$:
- (4) developing distribution weights $\{\mathbf{g}_1(k, l; n_2, n_1)\}$ and $\{\mathbf{g}_2(k, l; n_1, n_2)\}$ that perform equivalent substantive nulling operations during transmit signal formation operations;
 - (5) scaling distribution weights to optimize network capacity and/or power criteria, as appropriate for the specific node topology and application addressed by the network;
 - (6) removing residual timing and carrier offset remaining after recovery of the intended network data symbols;

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(7) encoding data onto symbol vectors based on the end-to-end SINR obtainable between each transmit and intended recipient node, and decoding that data after symbol recovery operations, using channel coding and decoding methods develop in prior art.

56. (currently amended) A method as in claim 1, wherein dynamically adapting the diversity ehannels [capability means] and said proper subsets to optimize said network further comprises:

forming substantively nulling combiner weights using an FFT-based least-squares algorithms that adapt $\{\mathbf{W}_1(k,l;n_2,n_1)\}$ and $\{\mathbf{W}_2(k,l;n_1,n_2)\}$ to values that minimize the mean-square error (MSE) between the combiner output data and a known segment of transmitted pilot data;

applying the pilot data to an entire OFDM symbol at the start of an adaptation frame comprising a single OFDM symbol containing pilot data followed by a stream of OFDM symbols containing information data;

wherein the pilot data transmitted over the pilot symbol is preferably given by EQ. 44 and EQ. 45,

$$p_1(k; n_2, n_1) = d_1(k, 1; n_2, n_1)$$

$$= p_{01}(k) p_{21}(k; n_2) p_{11}(k; n_1)$$

$$p_2(k; n_1, n_2) = d_2(k, 1; n_1, n_2)$$

$$= p_{02}(k) p_{12}(k; n_1) p_{22}(k; n_2)$$

such that the "pseudodelays" $\delta_1(n_1)$ and $\delta_2(n_2)$ are unique to each transmit node (in small networks), or provisioned at the beginning of communication with any given recipient node (in which case each will be a function of n_1 and n_2), giving each pilot symbol a pseudorandum component;

maintaining minimum spacing between any pseudodelays used to communicate with a given recipient node that is larger than the maximum expected timing offset observed at that recipient node, said spacing should also being an integer multiple of 1/K, where K is the number of tones used in a single FFT-based LS algorithm;

and if K is not large enough to provide a sufficiency of pseudodelays, using additional OFDM symbols for transmission of pilot symbols, either lengthening the effective value of K, or reducing the maximum number of originating nodes transmitting pilot symbols over the same OFDM symbol;

also providing K large enough to allow effective combiner weights to be constructed from the pilot symbols alone;

then obtaining the remaining information-bearing symbols, which are the uplink and downlink data symbols provided by prior encoding, encryption, symbol randomization, and channel preemphasis stages, in the adaptation frame, by [using] EQ. 46 and EQ. 47

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$$d_1(k,l;n_2,n_1) = p_1(k;n_2,n_1) d_{01}(k,l;n_2,n_1)$$

899
$$d_2(k,l;n_1,n_2) = p_2(k;n_1,n_2) d_{02}(k,l;n_1,n_2);$$

removing at the recipient node, first the pseudorandom pilot components from the received data by multiplying each tone and symbol by the pseudorandom components of the pilot signals, using EQ. 47 and EQ. 48

903
$$d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2) d_{02}(k, l; n_1, n_2)$$

904
$$\mathbf{x}_{02}(k, l; n_2) = c_{01}(k; n_2) \mathbf{x}_2(k, l; n_2);$$

thereby transforming each authorized and intended pilot symbol for the recipient node into a complex sinusoid with a slope proportional to the sum of the pseudodelay used during the pilot generation procedure, and the actual observed timing offset for that link, and leaving other, unauthorized pilot symbols, and symbols intended for other nodes in the network, untransformed and so appearing as random noise at the recipient node.

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913 57. (currently amended) A method as in claim 55, wherein the FFT-Least Squares 914 algorithm is that shown in Figure 37. [further comprises:

using a pilot symbol, which is multiplied by a unit-norm FFT window function; passing that result to a QR decomposition algorithm and computing orthogonalized data $\{\mathbf{q}(k)\}$ and an upper-triangular Cholesky statistics matrix \mathbf{R} ;

then multiplying each vector element of $\{\mathbf{q}(k)\}$ by the same unit-norm FFT window function and passing it through a zero-padded inverse Fast Fourier Transform (IFFT) with output length PK, with padding factor P to form

uninterpolated, spatially whitened processor weights $\{\mathbf{u}(m)\}$, where lag index

m is proportional to target pseudodelay $\delta(m) = m/PK$;

then using the spatially whitened processor weights to estimate the mean-squareerror (MSE) obtaining for a signal received at each target pseudodelay,

 $\varepsilon(m) = 1 - ||\mathbf{u}(m)||^2$, yielding a detection statistic (pseudodelay indicator

function), with an extreme at IFFT lags commensurate with the observed

pseudodelay and designed to minimize interlag interference between pilot signal

features in the pseudodelay indicator function;

using an extremes-finding algorithm to detect each extreme;

estimating the location of the observed pseudodelays to sub-lag accuracy;

determining additional ancillary statistics;

932 selecting the extremes beyond a designated MSE threshold: 933 interpolating spatially whitened weights U from weights near the extremes; 934 using the whitened combiner weights U to calculate both unwhitened combiner weights $\mathbf{W} = \mathbf{R}^{-1}\mathbf{U}$ to be used in subsequent data recovery operations, and to 935 estimate the received channel aperture matrix $\mathbf{A} = \mathbf{R}^H \mathbf{U}$, to facilitate ancillary 936 937 signal quality measurements and fast network entry in future adaptation frames; 938 and, lastly, using an estimated and optimized pseudodelay vector $\boldsymbol{\delta}_*$ to generate $\mathbf{c}_1(k)=$ 939 $\exp\{-j2\pi\boldsymbol{\delta}_{*}k\}$ (conjugate of $\{p_{11}(k;n_{1})\}$ during uplink receive 940 operations, and $\{p_{22}(k;n_2)\}$ during downlink receive operations), which is then 941 942 used to remove the residual observed pseudodelay from the information bearing

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symbols.

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58. (original) A method as in claim 55, wherein the pseudodelay estimation is refined using a Gauss-Newton recursion using the approximation:

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$$\exp\{-j2\pi\Delta(k-k_0)/PK\} \approx 1 -j2\pi\Delta(k-k_0)/PK$$
.

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59. (currently amended) A method as in claim 1, wherein wherein dynamically adapting the diversity ehannels [capability means] and said proper subsets to optimize said network further comprises:

using the linear combiner weights provided during receive operations are construct linear distribution weights during subsequent transmit operations, by setting distribution weight $\mathbf{g}_1(k,l;n_2,n_1)$ proportional to

 $\mathbf{w}^*_1(k, l; n_2, n_1)$ during 957 uplink transmit operations, and $\mathbf{g}_2(k,l;n_1,n_2)$ proportional to $\mathbf{w}^*_2(k,l;n_1,n_2)$ during downlink 958 959 transmit operations; thereby making the transmit weights substantively nulling 960 and thereby allowing each node to form frequency and time coincident two-way 961 links to every node in its field of view, with which it is authorized (through 962 establishment of link set and transfer of network/recipient node information) to 963 communicate. 964 965 60. (original) A method as in claim 1, wherein each node in the first subset of nodes 967 further comprises: 968

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a LEGO implementation element and algorithm.

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971 61. (currently amended) A method as in claim 1, wherein dynamically adapting the 972 diversity ehannels [capability means] and said proper subsets to optimize said network 973 further comprises:

974 balancing the power use against capacity for each channel, link, and node, and 975 hence for the network as a whole by:

establishing a capacity objective \mathbf{B} [$\{\beta(m)\}$] for a particular Node 2 976 977 [user 2 node] receiving from [a user 1 node] another Node 1 as the target 978 to be achieved by the [user 2 node] node 2[:]

979 solving, at [the user 2 node] Node 2 the local optimization problem:

980
$$\min \Sigma_{\mathbf{q}} \, \pi_{\mathbf{l}}(q) = [=] \, \mathbf{1}^{\mathrm{T}} \, \mathbf{\pi}_{\mathbf{l}}, \text{ such that}$$

981
$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \ge \beta(m),$$

where $\pi_1(q)$ is the SU (user 1 node) transmit power for link 982 983 number q [Q] for the user 1 node,

984	$\gamma(q)$ is the signal to interference [and] noise ratio (SINR) seen at
985	the output of the beamformer,
986	1 is a vector of all 1s,
987	and,
988	$oldsymbol{\pi}_1$ is a vector whose q^{th} -element is $oldsymbol{\pi}_1(q)$ [q^{th} element is $oldsymbol{\pi}_1(q)$
989	·],
990	the aggregate set $\mathbb{Q}(m)$ [$\mathbb{Q}(m)$] contains a set of links that are
991	grouped together for the purpose of measuring capacity flows
992	through those links;
993	using at Node 2 [the user 2 node] the local optimization solution to
994	moderate the transmit and receive weights, and signal information,
995	returned to node 1 [user 1 node];-
996	and,
997	using said feedback to compare against the capacity objective B
998	[$\{eta(m)\}$] and incrementally adjust the transmit power at each of Node
999	1 [the user 1 node] and Node 2 [the user 2 node] until no further
1000	improvement is perceptible.
1001	
1002	
1003	62. (currently amended) A method as in claim 1, wherein dynamically adapting the
1004	diversity ehannels [capability means] and said proper subsets to optimize said network
1005	further comprises:
1006	using the downlink objective function in EQ. 5 and EQ. 6
1007	$\min \Sigma_q \pi_2(q) = 1^T \mathbf{\pi}_2 \text{ such that } \Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \ge 1$
1008	eta(m)
1009	at each node to perform local optimization;
1010	reporting the required feasibility condition, $\sum_{q \in O(m)} \pi_1(q) \leq R_1(m)$

- 1011 $\sum_{q \in Q(m)} \pi_1(q) \le R_1(m)$;
- 1012 and,
- modifying $\beta(m)$ as necessary to stay within the constraint.
- 10141015
- 1016 63. (original) A method as in claim 60[61], wherein:
- the capacity constraints $\beta(m)$ are determined in advance for each proper subset
- of nodes, based on known QoS requirements for each said proper subset.
- 10191020
- 1021 64. (currently amended) A method as in claim 60[61], wherein said network further
- seeks to minimize total power in the network as suggested by EQ. 4
- $\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \ge \beta(m).$
- 10241025
- 1026 65. (currently amended) A method as in claim 60[61], wherein said network sets as
- 1027 a target objective for the network f B [$\{eta(m)\}$] the QoS for the network.
- 10281029
- 1030 66. (currently amended) A method as in claim 60[61], wherein said network sets as
- 1031 a target objective for the network \mathbf{B} [$\{\beta(m)\}$] a vector of constraints.
- 10321033
- 1034 67. (currently amended) A method as in claim 60[61], wherein the local
- optimization problem is further defined such that:
- 1036

1037 the receive and transmit weights are unit normalized with respect to the 1038 background interference autocorrelation matrix; 1039 1040 the local SINR is expressed as-EQ. 8 $\gamma(q) = \frac{P_{rt}(q,q)\pi_t(q)}{1+\sum_{t} P_{rt}(q,j)\pi_t(j)}$ 1041 1042 1043 and the weight normalization in EQ. 6 $\Sigma_{a \in O(m)} \log(1 + \gamma(q)) \ge \beta(m)$] 1044 is used to enable [$D_{12}(\mathbf{W},\mathbf{G}) = D_{21}(\mathbf{G}^*,\mathbf{W}^*)$, where $(\mathbf{W}_2,\mathbf{G}_1)$ 1045 and $(\mathbf{W}_1, \mathbf{G}_2)$ represent the receive and transmit weights employed by all 1046 1047 nodes in the network during uplink and downlink operations, respectively,] the 1048 reciprocity equation at that node, thereby allowing the uplink and downlink 1049 function to be presumed identical rather than separately computed. 1050 1051 1052 68. (currently amended) A method as in claim 60[61], wherein: 1053 very weak constraints to the transmit powers are approximated by using a very simple approximation for $\frac{\gamma(q)}{\gamma(q)}$ [$\gamma(q)$]. 1054 1055 1056 1057 69. (currently amended) A method as in claim 60[61], for the cases wherein all the 1058 aggregate sets contain a single link and non-negligible environmental noise is present,

wherein the transmit powers are computed as Perron vectors from EQ. 10,

$$D_{21} = \log \left(1 + \frac{1}{\rho(\mathbf{P}_{21}) - 1} \right)$$

$$= \log \left(1 + \frac{1}{\rho(\mathbf{P}_{12}^T) - 1} \right)$$

$$= D_{12}$$

$$= D_{12}$$

and a simple power constraint is imposed upon the transmit powers.

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70. (currently amended) A method as in claim 60[69], wherein the optimization is performed in alternating directions and repeated.

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71. (currently amended) A method as in claim 60[61], wherein each node presumes the post-beamforming interference energy remains constant for the adjustment interval and so solves EQ. 3 [

1071
$$\min_{\pi_1(q)} \sum_{q} \pi_1(q) = \mathbf{1}^T \ \mathbf{\pi}_1 \quad \text{, subject to the constraint of}$$

1072
$$\Sigma_{q \in Q(m)} \log(1 + \gamma(q)) \ge \beta(m)$$

using classic water filling arguments based on Lagrange multipliers, and then uses a similar equation for the reciprocal element of the link.

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72. (currently amended) Amethod as in claim 60[61], wherein at each node the constrained optimization problem stated in EQ. 13 and 14

1079
$$\max_{m} \sum_{q \in Q(m)} \log(1 + \gamma(q)), \text{ such that }$$

1080
$$\sum_{q \in Q(m)} \pi_1(q) \le R_1(m), \ \gamma(q) \ge 0$$

is solved using the approximation in EQ. 11, [

1082
$$\gamma(q) = \frac{P_{21}(q,q)\pi_1(q)}{i_2(q)}$$

and the network further comprises at least one high-level network controller that controls

the power constraints $R_1(q)$ [$R_1(m)$], and drives the network towards a max-min

1085 solution.

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1088 73. (currently amended) A method as in claim 60[61], wherein each node:

is given an initial γ_0 .

generates the model expressed in EQ. 20, EQ. 21, and EQ. 22;

1091 updates the new γ_{α} from EQ. 23 and EQ. 24;

determines a target SINR to adapt to;

1093 and,

updates the transmit power for each link q according to EQ. 25 and EQ. 26

1095
$$\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$$

1096
$$\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2 \quad \text{j.}$$

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1099 74. (currently amended) A method as in claim 60[61], for each node wherein the

1100 transmit power relationship of EQ. 25 and EQ 26

1101
$$\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$$

1125 and,

receives back for each link a single real number being the transmit power.

1127

1128 76. (original) A method as in claim 75, that for each pair of nodes assigns to the one

presently possessing the most processing capability the power management

1130 computations.

1131

1132

1133 77. (currently amended) A method as in claim 74[75] that estimates the transfer

gains and the post beamforming interference power using simple least squares estimation

1135 techniques.

1136

1137

1138 78. (currently amended) A method as in claim 74[75]that, for estimating the transfer

gains and post beamforming interference power:

1140

instead solves for the transfer gain h using EQ. 31

1142
$$[y(n) = hgs(n) + \varepsilon(n)];$$

uses a block of N samples of data to estimate h using EQ. 32 [

1144
$$h = \frac{\sum_{n=1}^{N} s^*(n) y(n)}{\sum_{n=1}^{N} |s(n)|^2 g}$$

obtains an estimation of residual interference power R_e [R_{ε}] using EQ. 33-

$$R_{\varepsilon} = \left\langle \left| \varepsilon(n) \right|^{2} \right\rangle$$

$$= \frac{1}{N} \sum_{n=1}^{N} \left(\left| y(n) \right|^{2} - \left| ghs(n) \right|^{2} \right)$$
];

1147 and, obtains knowledge of the transmitted data symbols S(n) from using 1148 1149 remodulated symbols at the output of the codec. 1150 1151 1152 79. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining knowledge of the transmitted data symbols S(n) from using remodulated symbols at the 1153 1154 output of the codec, the node uses the output of a property restoral algorithm used in a 1155 blind beamforming algorithm. 1156 1157 1158 80. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining knowledge of the transmitted data symbols S(n) from using remodulated symbols at the 1159 output of the codec, the node uses a training sequence explicitly transmitted to train 1160 1161 beamforming weights and asset the power management algorithms. 1162 1163 1164 81. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining knowledge of the transmitted data symbols S(n) from using remodulated symbols at the 1165 1166 output of the codec, the node uses any combination of: 1167 the output of a property restoral algorithm used in a blind beamforming algorithm; a training sequence explicitly transmitted to train beamforming weights and asset 1168 1169 the power management algorithms; 1170 or, 1171 other means known to the art. 1172 1173

```
1174
        82. (currently amended)
                                     A method as in claim 60[61], wherein each node
1175
        incorporates a link level optimizer and a decision algorithm, as illustrated in Figure
1176
        32Aand 32B.
1177
1178
        83. (currently amended)
                                      A method as in claim 81[82], wherein the decision
1179
        algorithm is a Lagrange multiplier technique.
1180
1181
1182
        84. (currently amended)
                                     A method as in claim 60[61], wherein the solution to EO. 3
1183
        is implemented by a penalty function technique.
1184
1185
1186
        85. (currently amended)
                                     A method as in claim 83[84], wherein the penalty function
1187
        technique:
               takes the derivative of \Upsilon_{(q)} [ \gamma(q) ] with respect to \pi_1;
1188
1189
               and,
1190
               uses the Kronecker-Delta function and the weighted background noise.
1191
1192
1193
        86. (currently amended)
                                     A method as in claim 83[84], wherein the penalty function
1194
        technique neglects the noise term.
1195
1196
1197
        87. (currently amended)
                                     A method as in claim 83[84], wherein the penalty function
1198
        technique normalizes the noise term to one.
1199
1200
1201
                                     A method as in claim 60[61], wherein the approximation
        88. (currently amended)
1202
        uses the receive weights.
1203
```

1205 89. (currently amended) A method as in claim 60[61], wherein adaptation to the

1206 target objective is performed in a series of measured and quantized descent and ascent

1207 steps.

1208

1209 90. (currently amended) A method as in claim 60[61], wherein the adaptation to the

target objective is performed in response to information stating the vector of change.

1211

1212

1213 91. (currently amended) A method as in claim 60[61], which uses the log linear

1214 mode in EQ. 34 [

1215
$$\beta_q \approx \log \left(\frac{a \ \pi_1(q) + a_0}{b \ \pi_1(q) + b_0} \right) = \hat{\beta}_q(\pi_1(q))$$

1216 and the inequality characterization in EQ. 35 [$\hat{\beta}_q(\pi_1(q)) \ge \beta$] to solve the

approximation problem with a simple low dimensional linear program.

1218

1219

1220 92. (currently amended) A method as in claim 60[61], develops the local mode by

matching function values and gradients between the current model and the actual

1222 function.

1223

1224

1225 93. (currently amended) A method as in claim 60[61], which develops the model as

a solution to the least squares fit, evaluated over several points.

1228

1231

1227

1229 94. (currently amended) A method as in claim 60[61], which reduces the cross-

1230 coupling effect by allowing only a subset of links to update at any one particular time,

wherein the subset members are chosen as those which are more likely to be isolated

from one another.

1233	
1234	
1235	
1236	95. (currently amended) A method as in claim 60[61], wherein:
1237	the network further comprises a network controller element;
1238	said network controller element governs a subset of the network;
1239	said network controller element initiates, monitors, and changes the target
1240	objective for that subset;
1241	said network controller communicates the target objective to each node in that
1242	subset;
1243	and,
1244	receives information from each node concerning the adaptation necessary to meet
1245	said target objective.
1246	
1247	
1248	96. (currently amended) A method as in claim 94[95], wherein said network further
1249	records the scalar and history of the increments and decrements ordered by the network
1250	controller.
1251	
1252	
1253	97. (currently amended) A method as in claim 60[61], wherein for any subset, a
1254	target objective may be a power constraint.
1255	
1256	
1257	98. (currently amended) A method as in claim 60[61], wherein for any subset, a
1258	target objective may be a capacity maximization subject to a power constraint.
1259	
1260	
1261	99. (currently amended) A method as in claim 60[61], wherein for any subset, a
1262	target objective may be a power minimization subject to the capacity attainment to the
1263	limit possible over the entire network.

1264	
1265	
1266	100. (currently amended) A method as in claim 60[61], wherein for any subset, a
1267	target objective may be a power minimization at each particular node in the network
1268	subject to the capacity constraint at that particular node.
1269	
1270	
1271	101. (currently amended) A wireless electromagnetic communications network,
1272	comprising:
1273	a wireless electromagnetic communications network, comprising
1274	a set of nodes, said set further comprising,
1275	at least a first subset wherein each node is MIMO-capable,
1276	comprising:
1277	a spatially diverse antennae array of M antennae, where M
1278	≥ one,
1279	a transceiver for each antenna in said array,
1280	means for digital signal processing,
1281	means for coding and decoding data and symbols,
1282	means for diversity transmission and reception,
1283	and,
1284	means for input and output from and to a non-radio
1285	interface;
1286	said set of nodes further comprising one or more proper subsets of nodes,
1287	being at least one transmitting and at least one receiving subset, with said
1288	transmitting and receiving subsets having a topological arrangement
1289	whereby:
1290	each node in a transmitting subset has no more nodes with which it
1291	will simultaneously communicate in its field of view, than it has
1292	number of antennae;
1474	number of antennae,

1293	each node in a receiving subset has no more nodes with which it
1294	will simultaneously communicate in its field of view, than it can
1295	steer independent nulls to;
1296	and,
1297	each member of a non-proper subset cannot communicate with any
1298	other member of its non-proper subset;
1299	transmitting independent information from each node in a first non-proper subset
1300	to one or more receiving nodes belonging to a second non-proper subset that are
1301	viewable from the transmitting node;
1302	processing independently information transmitted to a receiving node in a second
1303	non-proper subset from one or more nodes in a first non-proper subset is
1304	independently by the receiving node;
1305	and,
1306	optimizing the network by dynamically adapting the diversity channels [means for
1307	diversity transmission and reception] between nodes of said transmitting and receiving
1308	subsets.
1309	
1310	
1311	102. (currently amended) An apparatus as in claim 100 [101], further
1312	comprising an element for scheduling according to a Demand-Assigned, Multiple-Access
1313	algorithm.
1314	
1315	·
1316	103. (currently amended) An apparatus as in claim 100-[101], further comprising for
1317	each node in said first subset a LEGO adaptation element.
1318	
1319	
1320	104. (currently amended) An apparatus as in claim 100-[101], further comprising:
1321	for each node in said first subset a LEGO adaptation element; and,
1322	one or more network controllers.
1323	

1324	
1325	105. (currently amended) A method as in claim 1, wherein the step of dynamically
1326	adapting the diversity ehannels [capability means] and said proper subsets to optimize
1327	said network further comprises:
1328	
1329	matching each transceiver's degrees of freedom (DOF) to the nodes in the
1330	possible link directions;
1331	equalizing those links to provide node-equivalent uplink and downlink capacity.
1332	
1333	106. (original) A method as in claim 105, further comprising, after the DOF matching:
1334	assigning asymmetric transceivers to reflect desired capacity weighting;
1335	adapting the receive weights to form a solution for multipath resolutions;
1336	employing data and interference whitening as appropriate to the local conditions;
1337	and,
1338	using retrodirective transmission gains during subsequent transmission operations.
1339	
1340	
1341	107. (original) A method as in claim 105, wherein the receive weights are similarly-
1342	modified [matched to the nodes in the possible link directions].
1343	
1344	
1345	108. (currently amended) A method for optimizing a wireless electromagnetic
1346	communications network, comprising:
1347	a wireless electromagnetic communications network, comprising
1348	a set of nodes, said set of nodes further comprising,
1349	at least a first subset wherein each node is MIMO-capable,
1350	comprising:
1351	an antennae array of M [M] antennae, where M [M] \geq one,
1352	a transceiver for each antenna in said spatially diverse
1353	antennae array,

1354	means for digital signal processing to convert analog radio
1355	signals into digital signals and digital signals into analog
1356	radio signals,
1357	means for coding and decoding data, symbols, and control
1358	information into and from digital signals,
1359	diversity capability means for transmission and reception of
1360	said analog radio waves [signals];
1361	and,
1362	means for input and output from and to a non-radio
1363	interface for digital signals;
1364	said set of nodes being deployed according to design rules that prefer
1365	meeting the following criteria:
1366	
1367	said set of nodes further comprising two or more proper subsets of
1368	nodes, with a first proper subset being the transmit uplink / receive
1369	downlink set, and a second proper subset being the transmit
1370	downlink / receive uplink set;
1371	
1372	each node in said set of nodes belonging to no more transmitting
1373	uplink or receiving uplink subsets than it has diversity capability
1374	means;
1375	
1376	each node in a transmit uplink / receive downlink subset has no
1377	more nodes with which it will hold time and frequency coincident
1378	communications in its field of view, than it has diversity capability
1379	[means];
1380	
1381	each node in a transmit downlink / receive uplink subset has no
1382	more nodes with which it will hold time and frequency coincident
1383	communications in its field of view, than it has diversity capability
1384	[means];

1385	
1386	each member of a transmit uplink / receive downlink subset cannot
1387	hold time and frequency coincident communications with any
1388	other member of that transmit uplink / receive downlink subset;
1389	and,
1390	each member of a transmit downlink / receive uplink subset cannot
1391	hold time and frequency coincident communications with any
1392	other member of that transmit downlink / receive uplink subset;
1393	
1394	transmitting, in said wireless electromagnetic communications network,
1395	independent information from each node belonging to a first proper subset, to one
1396	or more receiving nodes belonging to a second proper subset that are viewable
1397	from the transmitting node;
1398	•
1399	processing independently, in said wireless electromagnetic communications
1400	network, at each receiving node belonging to said second proper subset,
1401	information transmitted from one or more nodes belonging to said first proper
1402	subset;
1403	
1404	optimizing at the local level for each node for the channel capacity ${f D}$ [D] $_{21}$
1405	according to EQ. 49, [

$$D_{21} = \max \beta \text{ such that}$$

$$\beta \leq \sum_{q \in U(m)} \sum_{k} \log(1 + \gamma(k, q)),$$

$$\gamma(k, q) \geq 0,$$

$$\sum_{R} R_{I}(m) \leq R,$$

$$\pi_{I}(k, q) \geq 0,$$

$$\sum_{q \in U(m)} \sum_{k} \pi_{I}(k, q) \leq R_{I}(m)$$
solving first the reverse link power control problem; then treating the forward link problem in an identical fashion, substituting the subscripts 2 for 1 in said equation;
and,
dynamically adapting the diversity ehannels [capability means] and said proper subsets to optimize said network.

1413
1414
1415
109. (currently amended) A method as in claim 108, futher comprising:
1416
1417
for each aggregate subset m , attempting to achieve the given capacity objective, β
1418
$$[\beta]$$
, as described in [
1419
$$[\min_{\pi_{I}(q)}] \sum_{q \in Q(m)} \pi_{I}(q), \quad \text{such that}$$
1420
$$\beta = \sum_{q \in Q(m)} \log(1 + \gamma(q))$$
1421
$$[\frac{1}{1}]$$
1422
$$[\frac{1}{1}]$$
1422

1423	simultaneously optimize the SINR;
1425	(2) based on the individual measured SINR for each $q [q]$ index, attempt to
1426	incrementally increase or lower its capacity as needed to match the current target;
1427	and,
1428	(3) step[p]ing the power by a quantized small step in the appropriate direction;
1429	then,
1430	when all aggregate sets have achieved the current target capacity, then the
1431	network can either increase the target capacity eta , or add additional users to
1432	exploit the now-known excess capacity.
1433	
1434	
1435	110. (currently amended) A method as in claim 106[107], wherein instead of
1436	optimizing for channel [capability means] capacity, the network optimizes for QoS [and
1437	not diversity capability means capacity].
1438	
1439	111. (currently amended) A method as in claim 94[95], wherein:
1440	said network controller adds, drops, or changes the target capacity for any node in
1441	the set the network controller controls.
1442	
1443	
1444	112. (currently amended) A method as in claim 94[95], wherein:
1445	said network controller may, either in addition to or in replacement for altering eta ,
1446	add, drop, or change channels between nodes, frequencies, coding, security, or
1447	protocols, polarizations, or traffic density allocations usable by a particular node
1448	or channel.
1449	
1450	
1451	113. (currently amended) A wireless electromagnetic communications network,
1452	comprising:

1453	a set of nodes, said set further comprising,
1454	at least a first subset wherein each node is MIMO-capable,
1455	comprising:
1456	a spatially diverse antennae array of $M[M]$ antennae, where
1457	$M[M] \ge $ one,
1458	a transceiver for each antenna in said array,
1459	13 means for digital signal processing,
1460	14 means for coding and decoding data and symbols,
1461	19 means for diversity transmission and reception,
1462	pilot symbol coding & decoding element
1463	timing synchronization element
1464	and,
1465	means for input and output from and to a non-radio
1466	interface;
1467	said set of nodes further comprising two or more proper subsets of nodes,
1468	there being at least one transmitting and at least one receiving subset, with
1469	said transmitting and receiving subsets subset having a diversity
1470	arrangement whereby:
1471	each node in a transmitting subset has no more nodes with which it
1472	will simultaneously communicate in its field of view, than it has
1473	number of antennae;
1474	each node in a receiving subset has no more nodes with which it
1475	will simultaneously communicate in its field of view, than it can
1476	steer independent nulls to;
1477	and,
1478	each member of a non-proper subset cannot communicate with any
1479	other member of its non-proper subset over identical diversity
1480	channels;
1481	a LEGO adaptation element and algorithm;
1482	a network controller element and algorithm;

1483 whereby each node in a first non-proper subset transmits independent information 1484 to one or more receiving nodes belonging to a second non-proper subset that are 1485 viewable from the transmitting node; 1486 each receiving node in said second non-proper subset processes independently 1487 information transmitted to a from one or more nodes in a first non-proper subset is 1488 independently by the receiving node; 1489 each node uses means to minimize SINR between nodes transmitting and 1490 receiving information; 1491 the network is designed such that substantially reciprocal symmetry exists for the 1492 uplink and downlink channels by, 1493 if the received interference is spatially white in both link directions, setting $g_1(aq) \propto W^*_2q$ and $g_2(q) \propto W^*_1(q)$ 1494 $[\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q) \text{ and } \mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)]$ at both ends of the link, 1495 where $\{g_2(q), \mathbf{W}_1(q)\}$ [$\{g_2(q), \mathbf{W}_1(q)\}$] are the linear transmit 1496 1497 and receive weights used in the downlink; 1498 1499 but if the received interference is not spatially white in both link directions, constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ 1500 [$\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$] to satisfy: 1501 1502 Q_{21} $\sum_{g}^{T} (q) R_{i+1} [n_1(q)] g *_1(q) =$ 1503 1504 1505 $\sum Tr\{R_{iiii}(n)\} = M_1R_{1;}$ 1506 1507

1509
$$\frac{\sum_{\mathbf{q}} \mathbf{f}_{2}^{T}(\mathbf{q}) \mathbf{R}_{i2i2}[\mathbf{n}_{2}(\mathbf{q})] \mathbf{g}^{*}_{2}(\mathbf{q})}{\sum_{\mathbf{q}=1}^{N_{1}} \mathbf{f}_{2}(\mathbf{q}) \mathbf{R}_{i2i2}[\mathbf{n}_{2}(\mathbf{q})] \mathbf{g}^{*}_{2}(\mathbf{q})} = 1511$$

$$\frac{\mathbf{q}=1}{\sum_{\mathbf{q}=1}^{N_{1}} \mathbf{g}_{1}^{T}(\mathbf{q}) \mathbf{R}_{\mathbf{i}_{1}\mathbf{i}_{1}}(n_{1}(\mathbf{q})) \mathbf{g}_{1}^{*}(\mathbf{q}) = \sum_{n=1}^{N_{1}} \mathrm{Tr} \left\{ \mathbf{R}_{\mathbf{i}_{1}\mathbf{i}_{1}}(n) \right\} = M_{1}R_{1}$$
1517
$$\sum_{\mathbf{q}=1}^{Q_{12}} \mathbf{g}_{2}^{T}(\mathbf{q}) \mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n_{2}(\mathbf{q})) \mathbf{g}_{2}^{*}(\mathbf{q}) = \sum_{n=1}^{N_{2}} \mathrm{Tr} \left\{ \mathbf{R}_{\mathbf{i}_{2}\mathbf{i}_{2}}(n) \right\} = M_{2}R_{2}$$
1518
$$\mathbf{g}_{1}^{*}$$
1519
the network uses any standard communications protocol;
1520
and,
1521
the network is optimized by dynamically adapting the [means for diversity transmission and reception] diversity channels between nodes of said transmitting and receiving subsets.
1524
1525
1526
114. (currently amended)
A wireless electromagnetic communications network as in claim $\frac{1+2}{113}$:
wherein each node may further comprise a Butler Mode Forming element, to enable said node to ratchet the number of active antennae for a particular uplink or downlink operation up or down.

1533 115. (currently amended) A wireless electromagnetic communications network as in 1534 claim 50[101]: 1535 incorporating a dynamics-resistant multitone element. 1536 1537 1538 116. (original) The use of a method as described in claim 1 for fixed wireless 1539 electromagnetic communications. 1540 1541 117. (currently amended) The use of an apparatus as described in claim 50[101] for 1542 fixed wireless electromagnetic communications. 1543 1544 118. (original) The use of a method as described in claim 1 for mobile wireless 1545 electromagnetic communications. 1546 1547 119. (currently amended) The use of an apparatus as described in claim 50[101] for 1548 mobile wireless electromagnetic communications. 1549 1550 120. (original) The use of a method as described in claim 1 for mapping operations using 1551 wireless electromagnetic communications. 1552 1553 121. (currently amended) The use of an apparatus as described in claim 50[101] for 1554 mapping operations using wireless electromagnetic communications. 1555 1556 122. (original) The use of a method as described in claim 1 for a military wireless 1557 electromagnetic communications network. 1558 1559 123. (currently amended) The use of an apparatus as described in claim 50[101] for a 1560 military wireless electromagnetic communications network. 1561 1562 124. (original) The use of a method as described in claim 1 for a military wireless 1563 electromagnetic communications network for battlefield operations.

1564 1565 125. (currently amended) The use of an apparatus as described in claim 50[101] for a 1566 military wireless electromagnetic communications network for battlefield operations. 1567 1568 126. (original) The use of a method as described in claim 1 for a military wireless 1569 electromagnetic communications network for Back Edge of Battle Area (BEBA) 1570 operations. 1571 1572 127. (original) The use of an apparatus as described in claim 50[101] for a military 1573 wireless electromagnetic communications network for Back Edge of Battle Area (BEBA) 1574 operations.. 1575 1576 128. (original) The use of a method as described in claim 1 for a wireless electromagnetic 1577 communications network for intruder detection operations. 1578 1579 129. (original) The use of an apparatus as described in claim 50[101] for a wireless 1580 electromagnetic communications network for intruder detection operations. 1581 1582 130. (original) The use of a method as described in claim 1 for a wireless electromagnetic 1583 communications network for logistical intercommunications. 1584 1585 131. (original) The use of an apparatus as described in claim 50[101] for a wireless 1586 electromagnetic communications network for logistical intercommunications. 1587 1588 132. (original) The use of a method as described in claim 1 in a wireless electromagnetic 1589 communications network for self-filtering spoofing signals. 1590 1591 133. (original) The use of an apparatus as described in claim 50[101] for a wireless 1592 electromagnetic communications network for self-filtering spoofing signals. 1593

1594 134. (original) The use of a method as described in claim 1 in a wireless 1595 electromagnetic communications network for airborne relay over the horizon. 1596 135. (original) The use of an apparatus as described in claim 50[101] for a wireless 1597 1598 electromagnetic communications network for airborne relay over the horizon. 1599 1600 136. (original) The use of a method as described in claim 1 in a wireless electromagnetic 1601 communications network for traffic control. 1602 1603 137. (currently amended) The use of a method as in claim 166[1], further comprising 1604 the use thereof for air traffic control. 1605 1606 138. (currently amended) The use of a method as in claim 166[1], further comprising 1607 the use thereof for ground traffic control. 1608 1609 139. (currently amended) The use of a method as in claim 166[1], further comprising 1610 the use thereof for a mixture of ground and air traffic control. 1611 1612 140. (original) The use of an apparatus as described in claim 50[101] for a wireless 1613 electromagnetic communications network for traffic control. 1614 1615 141. (currently amended) The use of an apparatus as in claim 170[101], further 1616 comprising the use thereof for air traffic control 1617 1618 142. (currently amended) The use of an apparatus as in claim $\frac{170}{101}$, further 1619 comprising the use thereof for ground traffic control. 1620

comprising the use thereof for a mixture of ground and air traffic control.

The use of an apparatus as in claim 170[101], further

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143. (currently amended)

1624 144. (original) The use of a method as in claim 1 in a wireless electromagnetic 1625 communications network for emergency services. 1626 1627 145. (original) The use of an apparatus as in claim 50[101] in a wireless electromagnetic 1628 communications network for emergency services. 1629 1630 146. (original) The use of a method as in claim 1 in a wireless electromagnetic 1631 communications network for shared emergency communications without interference. 1632 1633 147. (currently amended) The use of an apparatus as in claim 50[101] in a wireless 1634 electromagnetic communications network for shared emergency communications without 1635 interference. 1636 1637 148. (original) The use of a method as in claim 1 in a wireless electromagnetic 1638 communications network for positioning operations without interference. 1639 1640 149. (currently amended) The use of an apparatus as in claim 50[101]in a wireless 1641 electromagnetic communications network for positioning operations without interference. 1642 1643 150. (original) The use of a method as in claim 1 in a wireless electromagnetic 1644 communications network for high reliability networks requiring graceful degradation 1645 despite environmental conditions or changes.. 1646 1647 151. (currently amended) The use of an apparatus as in claim 50[101] in a wireless 1648 electromagnetic communications network for high reliability networks requiring graceful 1649 degradation despite environmental conditions or changes... 1650 1651 152. (original) The use of a method as in claim 1 in a wireless electromagnetic 1652 communications network for a secure network requiring assurance against unauthorized 1653 intrusion. 1654

1655 153. (original) The use of a method as in claim 1 in a wireless electromagnetic 1656 communications network for a secure network requiring message end-point assurance. 1657 1658 154. (original) The use of a method as in claim 1 in a wireless electromagnetic 1659 communications network for a secure network requiring assurance against unauthorized 1660 intrusion and message end-point assurance. 1661 1662 155. (currently amended) The use of an apparatus as in claim 50[101] in a wireless 1663 electromagnetic communications network for a secure network requiring assurance 1664 against unauthorized intrusion. 1665 1666 156. (currently amended) The use of an apparatus as in claim 50[101] in a wireless 1667 electromagnetic communications network for a secure network requiring message end-1668 point assurance. 1669 1670 157. (currently amended) The use of an apparatus as in claim 50[101]in a wireless 1671 electromagnetic communications network for a secure network requiring assurance 1672 against unauthorized intrusion and message end-point assurance. 1673 1674 1675 158. (original) The use of a method as in claim 1 in a cellular mobile radio service. 1676 1677 159. (currently amended) The use of an apparatus as in claim 50[101]in a cellular 1678 mobile radio service. 1679 1680 160. (original) The use of a method as in claim 1 in a personal communication service. 1681 1682 161. (currently amended) The use of an apparatus as in claim 50[101]in a personal 1683 communication service.

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162. (original) The use of a method as in claim 1 in a private mobile radio service.

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163. (currently amended) The use of an apparatus as in claim 50[101]in a private mobile radio service. 164. (original) The use of a method as in claim 1 in a wireless LAN. 165. (currently amended) The use of an apparatus as in claim 50[101]in a wireless LAN. 166. (original) The use of a method as in claim 1 in a fixed wireless access service. 167. (currently amended) The use of an apparatus as in claim 50[101]in a fixed wireless access service. 168. (original) The use of a method as in claim 1 in a broadband wireless access service. 169. (currently amended) The use of an apparatus as in claim 50[101] in a broadband wireless access service. 170. (original) The use of a method as in claim 1 in a municipal area network. 171. (currently amended) The use of an apparatus as in claim 50[101] in a municipal area network. 172. (original) The use of a method as in claim 1 in a wide area network. 173. (currently amended) The use of an apparatus as in claim 50[101] in a wide area network. 174. (original) The use of a method as in claim 1 in wireless backhaul.

175. (currently amended) The use of an apparatus as in claim 50[101]in wireless backhaul. 176. (original) The use of a method as in claim 1 in wireless backhaul. $\cdot 1720$ 177. (currently amended) The use of an apparatus as in claim 50[101]in wireless backhaul. 178. (original) The use of a method as in claim 1 in wireless SONET. 179. (currently amended) The use of an apparatus as in claim 50[101]in wireless SONET. 180-181. (Cancelled) 182. (original) The use of a method as in claim 1 in wireless Telematics. 183. (currently amended) The use of an apparatus as in claim 50[101]in wireless Telematics.